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NATIONAL ACADEMIES AND THE PROGRESS OF RESEARCH[1]

II. THE FIRST HALF CENTURY OF THE NATIONAL ACADEMY OF SCIENCES

IN the days preceding the American Revolution, the Royal Society was to this country what it still is to the existing British Colonies: the central and authoritative representative of scientific research.[2] Americans eminent for their contributions to science were elected Fellows, and their papers appeared in the *Philosophical Transactions.* The list of colonial Fellows includes Cotton Mather, Bowdoin, Dudley, and the three Winthrops in New England; Franklin, Rittenhouse and Morgan in Pennsylvania; Banister, Clayton, Mitchell and Bird, in Virginia, and Garden and Williamson in the Carolinas. But so distant a body could not meet all local needs. Thus Franklin, active in every field, undertook the organization of the American Philosophical Society in 1743, some years before its time, as its early demise proved. In 1766 the American Society held at Philadelphia for Promoting Useful Knowledge was established and Franklin, then in Europe, was elected its first president. In the meantime the earlier society was revived, and

[1] For most of the material in the following pages the writer is indebted to a history of the "First Half Century of the National Academy of Sciences," prepared and edited by Frederick W. True in connection with the recent celebration of the fiftieth anniversary of the founding of the academy.

[2] See an excellent article by G. Browne Goode, from which the data used in the introduction of the present paper are taken: "The Origin of the National Scientific and Educational Institutions of the United States," Annual Report of the American Historical Association for 1889.

the amalgamation of the two in 1769 gave rise to a scientific body which has always exercised a powerful and beneficent influence on the progress of science in the United States. The prominence in the affairs of state of its leading members is illustrated in the frequent interruptions to the proceedings of the society between 1773 and 1779, when these men, who included Washington, Franklin, Jefferson and Adams, were occupied with the labors of organizing the new republic. The American Philosophical Society, modelled after the Royal Society, but embracing the whole field of knowledge, soon assumed great importance at its seat in Philadelphia, then the center of American scientific and literary life.

John Adams, when representing the United States in France, learned of the appreciation in which the Philosophical Society was held in academic circles. On his return to Boston in 1779 he suggested the establishment of the American Academy of Arts and Sciences, which was duly incorporated by act of the Massachusetts State Legislature in 1780. At this time the influence of France was naturally more potent than that of England, and the Academies of Paris were chosen as models by the charter members of the new organization.

The year 1778 marks the inception of an ambitious plan, proposed by the Chevalier Quesnay de Beaurepaire. His scheme for the Academy of Arts and Sciences of the United States had been endorsed by the King of France, the Royal Academies of Science and of the Fine Arts, and by Lavoisier, Condorcet and many eminent Frenchmen. The sum of sixty thousand francs was subscribed by wealthy Virginians, and a building was erected in Richmond in 1786. One (French) professor was appointed to make natural history collections and extensive plans for branch establishments in Baltimore, Philadelphia and New York were contemplated. But the French Revolution put an end to this intellectual exotic.

In the present paper, devoted primarily to the history of the National Academy, we must pass over many interesting developments in the early scientific life of the nation, some of which will be mentioned elsewhere. Reference must be made, however, to the incorporation of the American Association for the Advancement of Science in 1848, and the intense vitality which has enabled this body, in cooperation with many special societies of later origin, to bring the results of scientific research within the reach of an ever-widening public.

Alexander Dallas Bache, superintendent of the United States Coast Survey from 1843 to 1867, and one of the leading spirits of his time, was among the first to express publicly the demand for a national organization of American research officially recognized as such by Congress. In his presidential address to the American Association for the Advancement of Science in 1851 he emphasized the need of "an institution of science, supplementary to existing ones, to guide public action in reference to scientific matters."

> Suppose an institute of which the members belong in turn to each of our widely scattered states, working at their places of residence and reporting their results; meeting only at particular times, and for special purposes; engaged in researches self-directed, or desired by the body, called for by congress or by the executive, who furnish the means for the inquiries. . . . The public treasury would be saved many times the support of such a council, by the sound advice which it would give in regard to various projects which are constantly forced upon their notice, and in regard to which they are compelled to decide without the knowledge which alone can ensure a wise conclusion.
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> . . . Such a body would supply a place not occupied by existing institutions, and which our own

is, from its temporary and voluntary character, not able to supply.[3]

As president of the American Association, and as a prominent member of the American Philosophical Society and the American Academy of Arts and Sciences, he entertained no misconception regarding the admirable aims and the no less admirable successes of these older societies. Each performed then, as it does now, a useful function of broad scope, which the proposed organization was not to rival but to supplement. The American Philosophical Society continues to exert a wide and useful influence, drawing to its annual meetings in Philadelphia a large body of able men, representing every field of knowledge. Its strong vitality and its traditions of a scholarly past are shared by the American Academy, now rapidly increasing in membership and advantageously established in the permanent home provided for it in Boston by Alexander Agassiz. The American Association, like the British Association for the Advancement of Science, holds its annual meetings in widely scattered cities, thus bringing under its influence a great number of people, whose attention might not be attracted from a distance. Clearly there was still room for an academy chartered by congress and closely related to the national government, to which it might render some such services as the principal countries of Europe receive from their great academies.

Bache's hopes were to be realized twelve years later. On February 11, 1863, Gideon Welles, secretary of the navy, appointed Admiral Davis, Professor Henry and Professor Bache a "Permanent Commission" "to which shall be referred questions of science and art upon which the (navy) department may require information."[4] Encouraged by this governmental recognition, Bache, Peirce, Davis, Gould and Agassiz induced Senator Wilson, of Massachusetts, to introduce in congress a bill to incorporate the National Academy of Sciences. This passed the Senate and House on March 3, 1863, and was signed by the president on the same day.

The act of incorporation named fifty men of science as charter members, and limited the membership of the Academy to this number. A second act of congress, passed in 1870, removed this limitation. At present the amended constitution provides that ten new members may be elected annually, and fixes the limiting membership at one hundred and fifty. The actual number of names now on the roll is one hundred and thirty-two. In addition to these there are forty-nine foreign associates and one honorary member.

The list of incorporators contains many distinguished names: Agassiz, Alexander, Bache, Barnard, Dana, Davis, Gilliss, Gould, Wolcott Gibbs, Asa Gray, Guyot, James Hall, Henry Hilgard, Le Conte, Leidy, Lesley, Newberry, Newton, Peirce, Rogers, Rutherfurd, Silliman, Torrey, Whitney, Wyman—among others equally well known. Chosen from the country at large, and fairly representative of the science of the day, the membership was worthy of a truly national body.

The organization of the National Academy was "the first recognition by our government of the importance of abstract science as an essential element of mental and material progress."[5] One of the objects in the minds of its founders was to confer distinction on men of science who had accomplished important original research, and thus to encourage and stimulate them

[3] *Op. cit.*, pp. 7, 8.

[4] *Op. cit.*, p. 1.

[5] From the report for 1867 of Joseph Henry, president of the National Academy, *op. cit.*, p. 14.

to further effort. Another prime object was to aid the government in the solution of problems of a scientific nature. In 1863, the year of the Academy's incorporation, the civil war was in progress, and the government stood in need of just such advice as a body of able scientific men could supply. It will be seen later that the assistance of the Academy was often sought and rendered, not alone in this period, but also in subsequent years.

The idea that a democratic government could not consistently confer distinction upon its citizens, though held by some critics of the day, was not shared by Joseph Henry, whose words may again be quoted from the report cited above:

> It is not enough for our government to offer encouragement to the direct promotion of the useful arts through the more or less fortunate efforts of inventors; it is absolutely necessary, if we would advance or even preserve our reputation for true intelligence, that encouragement and facilities should be afforded for devotion to original research in the various branches of human knowledge. In the other countries scientific discovery is stimulated by pensions, by titles of honor and by various social and official distinctions. The French academicians receive an annual salary and are decorated with the insignia of the Legion of Honor. Similar marks of distinction are conferred on the members of the Academy of Berlin and that of St. Petersburg. These modes of stimulation or encouragement may be considered inconsistent with our social ideas and perhaps with our forms of government. There are honors, nevertheless, which in an intelligent democracy have been and may be justly awarded to those who enlarge the field of human thought and human power. Heretofore, but two principal means of distinction have been recognized in this country, viz.: the acquisition of wealth and the possession of political power. The war seems to have offered a third, in bestowing position and renown for successful military achievement. The establishment of this Academy may be perhaps regarded as having opened a fourth avenue for the aspirations of a laudable ambition, which interferes neither with our national prejudices nor our political principles, and which only requires the fostering care of government to become of essential benefit and importance not only to this, but all the civilized countries of the world.[6]

The special problems raised by the civil war emphasized the value of the services which the Academy might render the government, at a period when most of the scientific bureaus of later years were not yet organized. But the war had only an incidental bearing on the designation of the Academy as the scientific adviser of the nation. The desire of President Lincoln and his Secretary of State to receive advice from the Academy on more general questions is shown by the following letter from Secretary Seward to President Bache:[7]

> Department of State,
> Washington, January 8, 1864.
>
> *Sir:* I have the honor to acknowledge the receipt of your note of the 7th instant, tendering to this department the aid of the Academy of Sciences in any investigation that it may be thought proper to institute with a view to the great reform of producing an uniformity of weights and measures among commercial nations. Be pleased to express to the Academy my sincere thanks for this enlightened and patriotic proceeding, and assure them that, with the authority of the President, I shall be happy to avail myself of the assistance thus tendered to me, and to that end I shall at all times be happy to receive the suggestions of the Academy, or of any committee that may be named by it, in conformity with the spirit of the note you have addressed to me.
>
> I am, Sir, your obedient servant,
> William H. Seward

We shall have occasion later to consider how the Academy has assisted the government in the solution of problems of the most diverse character.

The first meeting of the National Academy, attended by more than three fifths of the incorporators, was held at the University of the City of New York on April 22, 1863. Senator Wilson, who had introduced in the senate the bill of incorporation, ad-

[6] *Op. cit.*, p. 14.

[7] *Op. cit.*, p. 16.

dressed the Academy at the opening of the first session. After alluding to the fact that the idea of forming such an institution had long existed, he dwelt on the significance of unanimous action by congress at a time when the country was suffering under the burden of the great civil war. With its widely distributed membership, he felt that the Academy would contribute in the future toward the unity and indivisibility of the nation.

With Professor Henry in the chair, and other leaders of American science taking part in the deliberations, the work of the Academy was begun under the most favorable auspices. The constitution and by-laws were prepared by a strong committee, including such men as Agassiz, Benjamin Gould, Peirce and Silliman, with Bache as chairman. After three days of discussion they were adopted by the Academy, and finally ratified at the first Washington meeting, held in one of the committee rooms of the senate on January 4–6, 1864.

In the space at our disposal, we must content ourselves with a brief glance at the principal acts of the Academy during the fifty years of its existence, referring the reader to the work so often cited for further details. In accordance with the terms of the constitution, the members were divided into two classes, (*a*) mathematics and physics, and (*b*) natural history, each class having a chairman and secretary. The names of the sections, and the number of members in each, are given in the following table:

Class of Mathematics and Physics

		Number of Members	
Sect. 1.	Mathematics	6	
Sect. 2.	Physics	6	
Sect. 3.	Astronomy, Geography and Geodesy	9	
Sect. 4.	Mechanics	6	
Sect. 5.	Chemistry	3	30

Class of Natural History

		Number of Members	
Sect. 1.	Mineralogy and Geology	6	
Sect. 2.	Zoology	5	
Sect. 3.	Botany	1	
Sect. 4.	Anatomy and Physiology	2	
Sect. 5.	Ethnology	0	14
	Total		44

It is interesting to contrast this organization with that existing at the present time:

Sect. 1.	Mathematics and Astronomy	23	
Sect. 2.	Physics and Engineering	25	
Sect. 3.	Chemistry	23	
		71	
	Deduct names counted twice.	5	66
Sect. 4.	Geology and Paleontology	24	
Sect. 5.	Botany	9	
Sect. 6.	Zoology and Animal Morphology.	18	
Sect. 7.	Physiology and Pathology	15	
Sect. 8.	Anthropology and Psychology	9	
		75	
	Deduct names counted twice	9	66
	Total		132

At the outset, two thirds of the members belonged to the class of mathematics and physics, and only one third to the class of natural history. At present, while the two classes no longer exist as such, it is easy to group the members in the same way. Deducting the names counted twice, we find that 66 would now fall in the first class, and exactly the same number in the second. Thus the discrepancy formerly existing between the two classes has been adjusted in the process of time.[8]

It is important to note that the division of members into sections is solely for the purpose of facilitating nominations for new elections, as now provided by the constitution.

[8] DeCandolle notes a similar preference for the mathematical and physical sciences on the part of the Berlin Academy during the eighteenth century, which was subsequently adjusted by revision of the statutes. ("Histoire des Sciences et des Savants," 2 ed., p. 261.)

In view of the preponderance of physicists, it is not surprising that three fourths of the scientific papers read at the first Washington meeting were connected with the physical sciences. These papers were referred to the committee on publication, with instructions to publish, but the lack of funds for this purpose stood in the way. When the first volume of the *Memoirs* finally appeared in 1866, it contained but two of these papers. It was then planned to print the minor papers in the *Proceedings* of the academy, but this was never done. The first part of the first volume of the *Proceedings* was published in 1877. This contained the constitution and by-laws, reports on the principal business actions of the Academy, and much miscellaneous matter relating to resolutions passed, titles of papers presented, reports of committees, etc. Publication of the *Proceedings* was discontinued in 1895, after three parts had appeared.[9] In 1881, 649 papers had been read at the scientific sessions. President Rogers, feeling that the Academy would have received much more recognition from the scientific world if these had been printed, strongly and repeatedly urged that the papers be collected annually and transmitted to congress with the report.[10] Unfortunately this was never done, and the reports still give only an abstract of the proceedings, in which the papers appear by title. The importance of reviving and enlarging the *Proceedings* will be discussed in another article.

The Academy has published eleven volumes of *Memoirs,* containing 68 quarto papers, and seven volumes of *Biographical Memoirs* of deceased members, in addition to annual reports and reports of committees.

In view of the existence of a detailed history of the Academy, it is quite unnecessary in the present paper to dwell at length upon the events of the first fifty years. A brief outline of the more important work of the Academy is nevertheless essential to clearness, especially in connection with the suggestions for the future which are to be presented later. We may, therefore, consider briefly: (1) the work of the members; (2) the Academy's work for the national government; (3) medals and trust funds, and (4) cooperation in research.

[9] *Op. cit.*, p. 44.

[10] *Op. cit.*, p. 51.

THE WORK OF THE MEMBERS

In his report for 1867 as president of the Academy, Joseph Henry spoke as follows of the conditions of membership:

> It was implied in the organization of such a body that it should be exclusively composed of men distinguished for original research, and that to be chosen one of its members would be considered a high honor, and consequently a stimulus to scientific labor, and that no one would be elected into it who had not earned the distinction by actual discoveries enlarging the field of human knowledge.
>
> . . . since the original organization, the principle before mentioned has been strictly observed, and no one has been admitted except after a full discussion of his claims and a satisfactory answer to the question, "What has he done to advance science in the line of research which he has especially prosecuted?"

And again, in his valedictory address to the Academy (1878), Henry returned to this subject.

> For this purpose great care must be exercised in the selection of its members. It must not be forgotten for a moment that the basis of selection is actual scientific labor in the way of original research; that is, in making positive additions to the sum of human knowledge, connected with unimpeachable moral character.
>
> It is not social position, popularity, extended authorship or success as an instructor in science, which entitles to membership, but actual new discoveries, nor are these sufficient if the reputation of the candidate is in the slightest degree tainted with injustice or want of truth.

These principles have been observed to the present day, sometimes in the face of great temptation to elect men eminent for achievements other than those of original research. Thus the Academy has counted among its members the large majority of the leaders of American science. While it is of course impossible to describe their individual contributions in these pages,[11] some remarks on the progress of American research since the foundation of the Academy will be given in a later paper.

THE WORK OF THE ACADEMY FOR THE NATION

In the first annual report of the president of the Academy, presented to congress in 1864, Professor Bache remarked:

> The want of an institution by which the scientific strength of the country may be brought, from time to time, to the aid of the government in guiding action by the knowledge of scientific principles and experiments, has long been felt by the patriotic scientific men of the United States. No government of Europe has been willing to dispense with a body, under some name, capable of rendering such aid to the government, and in turn of illustrating the country by scientific discovery and by literary culture.

In a previous paper the distinctive position held by European academies as organizations of the government, and the services they render to the state, have been briefly described.[12] Here, as elsewhere in these papers, we must not overlook the special conditions which distinguish the National Academy from similar bodies abroad. The Royal Society and the Paris Academy of Sciences, dating from the earliest beginnings of science in England and France, have been the media through which the great advances of more than two centuries have reached the world. Discovery after discovery, first presented at their meetings and published in their proceedings, has been rigidly associated in the public mind with these great societies, which have fostered science and encouraged the labors of investigators. Thus they have acquired a prestige and a power in the state which could arise in no other way. It is not enough for a nation to charter an organization and to authorize it to act as the adviser of the government in scientific affairs. Appreciation of the fundamental importance of science as the source of all industrial progress, and confidence in the body appointed to advise the nation, are obvious prerequisites to that cooperation between statesmen and men of science which is essential to complete success.

In spite of the disadvantage of a widely scattered membership, whose discoveries and contributions to science have always reached the world through other channels, and with no home of its own to focus attention on its activities, the National Academy has often been called into the service of the country. It will be sufficient to give here a list of the subjects on which the Academy has been consulted by the government, referring the reader to the "History of the National Academy" (pp. 201 to 331) for all details.

COMMITTEES APPOINTED BY THE ACADEMY ON BEHALF OF THE GOVERNMENT

1. Committees appointed in accordance with Acts of Congress.
   - 1871. On the Transit of Venus.
   - 1872. On Preparing Instructions for the *Polaris* Expedition.
   - 1878. On a Plan for Surveying and Mapping the Territories of the United States.
   - 1879. On a National Board of Health.
   - 1894. To Prescribe and Publish Specifications for the Practical Application of the Definitions of the Ampere and Volt.

[11] Biographies of the incorporators may be found in the "History of the National Academy," so often cited.

[12] SCIENCE, November 14, 1913.

1908. On the Methods and Expenses of Conducting Scientific Work Under the Government.

2. Committees appointed at the request of Joint Commissions and Committees of Congress.
   1884. On the Signal Service of the Army, the Geological Survey, the Coast and Geodetic Survey, and the Hydrographic Office of the Navy Department.
   1902. On the Establishment of a National Forest Reserve in the Southern Appalachians.

3. Committees appointed at the request of the President of the United States.
   1870. On the Protection of Coal Mines from Explosion by Means of Electricity.
   1902. On Scientific Explorations in the Philippines.

4. Committees appointed at the request of the Treasury Department.
   1863. On the National Currency (Confidential).
   1863. On Weights, Measures and Coinage.
   1863. On Saxton's Alcoholometer.
   1864. On Materials for the Manufacture of Cent Coins.
   1866. On the Prevention of Counterfeiting.
   1866. On Spirit Meters.
   1866. On Proving and Gauging Distilled Spirits and Preventing Fraud.
   1866. On Metric Standards for the States.
   1870. On the Effect of Chemicals on Internal Revenue Stamps.
   1873. On an International Bureau of Weights and Measures.
   1875. On Water-proofing the Fractional Currency.
   1875. On Means of distinguishing Calf's Hair from Woolen Goods (Confidential).
   1876. On Artificial Coloring of Sugars to Simulate a Lower Grade According to the Standard on which Duties are Levied (Confidential).
   1876. On the Use of Polarized Light to Determine the Values of Sugars.
   1877. On Demerara Sugars.
   1878. On Building Stone to be used for the Custom House at Chicago (no report).
   1882. On the Separation of Methyl Alcohol or Wood Spirits from Ethyl Alcohol.
   1882. On Glucose.
   1882. On Triangulation Connecting the Atlantic and Pacific Coasts (no report).
   1884. On Philosophical and Scientific Apparatus.
   1885. On the Tariff Classification of Wools.
   1886 and 1887. On the Morphine Content of Opium.
   1887. On Quartz Plates used in Saccharimeters for Sugar Determinations.
   1890. To Formulate a Plan for a Systematic Search for the North Magnetic Pole.

5. Committees appointed at the request of the Navy Department.
   1863. On Protecting the Bottoms of Iron Vessels.
   1863. On Magnetic Deviation in Iron Ships.
   1863. On Wind and Current Charts and Sailing Directions.
   1864. On the Explosion on the United States Steamer *Chenango*.
   1864. On Experiments on the Expansion of Steam.
   1877. On Proposed Changes in the American Ephemeris.
   1881. On the Transit of Venus.
   1885. On the Astronomical Day, the Solar Eclipse of 1886, and the Erection of a New Naval Observatory.

6. Committees appointed at the request of the War Department.
   1864. On the Question of Tests for the Purity of Whiskey.
   1866. On the Preservation of Paint on Army Knapsacks.
   1867. On Galvanic Action from Association of Zinc and Iron.
   1873. On the Exploration of the Yellowstone.
   1881. On Questions of Meteorological Science and its Application.

7. Committees appointed at the request of the Department of State.
   1866. On the Improvement of Greytown Harbor, Nicaragua.
   1903. On the Restoration of the Declaration of Independence.

8. Committees appointed at the request of the Department of Agriculture.
   1870. On Silk Culture in the United States.
   1881. On Sorghum Sugar.

9. Committees appointed at the request of the Department of the Interior.
   1880. On the Restoration of the Declaration of Independence.

1896. On the Inauguration of a Rational Forest Policy for the Forested Lands of the United States.

It will be noticed that many of the questions referred to the Academy are of such a nature that, at the present day, they could be satisfactorily answered by one or another of the scientific departments of the government. This probably accounts for the fact that the requests for the Academy's assistance have become less numerous as the national laboratories and scientific bureaus have multiplied and improved. But after full allowance has been made for such wholly desirable developments, it remains true that questions of broad scope, requiring the cooperation of authorities in several fields of knowledge for their solution, must arise from time to time. In such cases the Academy can afford assistance obtainable in no other way, and an enlightened government will advantageously seek its counsel.

The overthrow of the spoils system in national politics will afford the Academy another opportunity to serve the nation. In France, when a professorship in the national university, or the directorship of a national observatory or laboratory falls vacant, the Academy of Sciences is requested to present its first and second choice of a successor. The Minister of Public Instruction then appoints one of the nominees to the position. In the United States the need of such counsel is no less urgent than in France.

MEDALS AND TRUST FUNDS

Election to the National Academy has always been appreciated as a high honor by American men of science. Fortunately, however, the recognition and assistance the Academy has been able to afford to investigators has not been confined to the gift of this mark of distinction. From time to time trust funds have been established, the incomes of which are devoted to the award of medals or to grants for research. The will of Alexander Dallas Bache, first president of the Academy, directed that the residue of his estate, after the death of his wife, should be paid over to the National Academy of Sciences for the "prosecution of researches in Physical and Natural Science by assisting experimentalists and observers." Bache's excellent example has often been followed, with the results shown in the following table:

Fund	Established	Original Capital	Present Capital	Purpose
Alexander Agassiz	1910	$50,000.00	$50,000.00	General use of the academy.
A. D. Bache	1879	47,500.00	56,000.00	Researches in physical and natural science.
Cyrus B. Comstock	1907	10,000.00	10,337.50	Prize every five years for investigations in electricity or magnetism or radiant energy.
Henry Draper	1885	6,000.00	10,000.00	Medal for investigations in astronomical physics. (Surplus for research.)
Wolcott Gibbs	1893	2,673.17	3,000.00	Aid of chemical science.
Benjamin Apthorp Gould	1897	20,000.00	20,000.00	Researches in astronomy.
O. C. Marsh	1912	9,377.65	9,377.65	Original research in the natural sciences.
John Murray	1911	6,000.00	6,000.00	To found Alexander Agassiz gold medal for original contributions in oceanography.
J. Lawrence Smith	1885	8,000.00	10,000.00	Lawrence Smith gold medal for original investigations of meteoric bodies. (Surplus for research.)
J. C. Watson	1883	18,666.82	25,000.00	Gold medal and money prize for astronomical investigations. (Surplus for research.)
Building Fund		7,000.00	7,000.00	

The importance of the part played by these funds in advancing science may be illustrated by reference to some of the results obtained.

The Agassiz Fund has proved to be of great value in meeting the general expenses of the Academy, for which there was formerly no provision except the dues of the members.

The Bache Fund made twelve appropriations to Hilgard for his magnetic survey of the United States, four to Langley for his important studies of the physical constitution of the sun, six to Wolcott Gibbs for his researches on complex inorganic acids and his studies of the action of chemical compounds upon the animal system, one each to Newcomb and Michelson for their classic determinations of the velocity of light, three others to Michelson for his equally fundamental optical researches, six to Rowland for his great work in mapping and identifying the lines of the solar spectrum, three to Pickering for his pioneer researches in stellar photography, two to Gould for his measurements of the Cordoba photographs of the southern heavens, six to Boss for his studies of solar and stellar motions and his precise measures of standard stars, and two to Osborn for the work of the Academy Committee on Correlation. These cases include only a fraction of the total number of grants from the fund.

The Barnard Gold Medal for Meritorious Services to Science, awarded every five years by Columbia University to the nominee of the National Academy, has been given to Rayleigh, Röntgen, Becquerel and Rutherford.

The first award of the Comstock Prize of fifteen hundred dollars was made last April to Professor Robert Millikan, of the University of Chicago, for his researches on the charge of the electron and related investigations.

The Henry Draper Gold Medal for astrophysical research has been awarded to Langley, Pickering, Rowland, Vogel, Keeler, Huggins, Hale, Campbell, Abbot and Deslandres. Several grants to assist investigation have also been made from the surplus income.

The capital of the Wolcott Gibbs Fund for chemical research is being increased by additions of accumulated income, and no grants are being made at present. The income of the Marsh Fund is also being added to the capital.

A large number of investigations have been assisted by the Gould Fund, including those of Doolittle, Parkhurst, Yendell, Newcomb, Leavenworth, Comstock and others. At present the income is used mainly for the support of the *Astronomical Journal.*

The Alexander Agassiz Gold Medal, established by Sir John Murray for oceanographic research, was awarded for the first time last April to Dr. Johan Hjort, of the Norwegian Fish Commission, for his valuable contributions to knowledge relating to deep-sea life.

The Lawrence Smith Gold Medal for the investigation of meteoric bodies has been awarded but once, to H. A. Newton, of Yale, for his researches on the orbits of meteors. Appropriations from the fund have supplied Yale University with apparatus for the photography of meteors, and provided for the publication of a catalogue of meteorites, for their chemical analysis and for the study of their luminous trains.

The Watson Fund has aided the important work of Chandler on the variation of latitude, and that of Comstock on the constant of aberration, in addition to many other important grants. Since 1901 the income has been very effectively used by Leuschner in the computation of the perturbations of the asteroids discovered by Watson. The Watson Gold Medal, with

one hundred dollars in gold, has been awarded to Gould, Schönfeld, Auwers, Chandler, Gill and Kapteyn for their astronomical investigations.

In view of its national charter, the high plane of its membership, and its special advantages as the representative of the United States in the International Association of Academies, the National Academy is most favorably qualified for the custody and efficient use of trust funds. Appreciation of this fact, amply indicated by the above list of gifts and bequests, should grow with the reputation of the Academy. It is safe to predict that the privilege of securing the Academy's aid in the control and disbursement of large sums for the benefit of science will be widely sought in the future. In this connection attention should be called to the present lack of medals and funds especially devoted to the recognition and aid of researches in mathematics, engineering, geology and various departments of biology and anthropology.

COOPERATION IN RESEARCH

As an agent for the furtherance of cooperative research, the National Academy occupies a unique position among American societies. In these days of far-reaching investigations, involving the common action of men of science distributed throughout the world, the great majority of cooperative projects are international in character. Here the peculiar advantage of the Academy appears. The International Association of Academies is made up of the national academies of sixteen countries. Each academy is pledged to support only such cooperative undertakings as are endorsed by the association. Thus the constituent members of this body, through their delegates at its triennial meetings, are most favorably placed for the initiation and furtherance of such international movements.

As an illustration of the work already undertaken by the National Academy in this field, mention may be made of the International Union for Cooperation in Solar Research. In 1904, the Academy, through its Committee on Solar Research, invited various academies, physical and astronomical societies, and other organizations interested in the subject, to send delegates to a conference, with a view to the initiation of international cooperation in this field. Meetings have since been held at Oxford in 1905, Paris in 1907, Mount Wilson in 1910 and Bonn in 1913. The constituent societies, each of which is represented in the Union by a standing committee, are as follows:

The Royal Society of London, the Academies of Amsterdam, Barcelona, Berlin, Paris, St. Petersburg, Stockholm and Vienna, the Swiss Society of Natural Sciences, the Astronomical Societies of London, America, France and Canada, the Physical Societies of Berlin, Italy, Spain, France and America, the Society of Italian Spectroscopists, the Solar Physics Committee, the Solar Sub-committee of the International Meteorological Committee and the National Academy of Sciences.

The standards of wave-lengths which are being established by the Union, as the result of extensive cooperative studies, will be used universally by spectroscopists. International committees, appointed by the Solar Union, are studying the solar rotation, the spectra of sun-spots and the intensity of the solar radiation, on a common plan. Spectroheliographs are also in use, for the almost continuous photography of the sun, at the observatories of Kodaikanal, India; Catania, Sicily; Potsdam, Germany; Meudon, France; Tortosa, Spain; Cambridge, England; Williams

Bay, Wisconsin; Tacubaya, Mexico; and Mount Wilson, California.

A new solar observatory, which is about to be established in New Zealand through the generosity of Mr. Thomas Cawthron, will fill the gap in longitude between California and India, and thus aid in keeping the rapidly changing phenomena of the solar atmosphere constantly under observation. At the Mount Wilson meeting of the Union, it was decided to enlarge its scope so as to include the whole range of astrophysics, and a representative committee was appointed to report on the classification of stellar spectra. It is now evident that the Solar Union is destined to play an increasingly important part in the field of international research.

The Solar Union is one of the organizations endorsed by the International Association of Academies, to which it makes regular reports. Another of the international investigations conducted under the auspices of the association is that of the Brain Commission, the American Committee of which is also closely related to the National Academy.

The Committee on International Paleontologic Correlation, appointed by the Academy in 1908, has recently completed its work. Aided by the Bache Fund, the committee has pushed forward the important work of correlating the geologic formations of Europe and America on the basis of their paleontologic contents. The results have been published in a series of papers, by members of the committee, most of which treat of the mammals of the tertiary epoch and the formations which contain them in North America. Marsh and Cope dealt with the formation of the American Eocene as units, even when their thickness ranged from 1,000 to 2,000 feet. These formational units have now been split up into sub-units, or life zones, usually distinguished by geologic discontinuity. At the same time there has been a marked increase in the precision of recording the succession of species in certain formations which contain several levels of life zones, thus permitting exact comparisons with other life zones to be instituted. The importance of such work is obvious in connection with the trend and rate of development in different parts of the world, the possibility of geographic intercourse at certain epochs, and the cycles of physiographic and climatic change.

It is thus evident that the Academy is in a most favorable position to extend its operations in the field of international research, where the advantages of its national and representative character are felt to the full, and the disadvantages of its scattered membership are of minor importance.

From this brief survey it appears that the National Academy of Sciences, in spite of many obstacles, has played an important part in the development of American science. The time is now favorable for an extension of its work into new fields, which must be occupied if the special opportunities and obligations implied by the Academy's national charter are to be fully realized. In a later article some of the possibilities of future progress will be considered.

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The Plan of Work in Connection with a New Marine Laboratory on the Pacific

During the past summer a new marine station was erected at Laguna Beach, California. At this place the varied and rocky coast offers peculiar advantages for the study of plant and animal life. The situation, too, is convenient for those in southern California, being within fifty miles from Los Angeles and easily accessible from other cities and towns.